AD-A044 778 FOREIGN TECHNOLOGY DIV WRIGHT-PATTERSON AFB OHIO F/G 17/2

EFFICIENCY OF MULTISTAGE COMMUNICATION SIGNAL SEARCH WITH CONSI--ETC(U)

MAR 77 Y S AGAFONOV

UNCLASSIFIED FTD-ID(RS)I-0391-77 NL

1 OF 1

ADA
044778

END

DATE
FILMED

10-77

DDC

AD-A044778

FTD-ID(RS)I-0391-77

(1)

FOREIGN TECHNOLOGY DIVISION

AIR FORCE SYSTEMS COMMAND

EFFICIENCY OF MULTISTAGE COMMUNICATION SIGNAL SEARCH WITH CONSIDERATION OF RECEIVER COMPLEXITY

by

Yu. S. Agafonov

FOREIGN TECHNOLOGY DIVISION

Approved for public release; distribution unlimited.

ACCESSION for
NTIS White Section ☒
DDC Buff Section ☐
UNANNOUNCED ☐
JUSTIFICATION ....

BY ....
DISTRIBUTION/AVAILABILITY CODES
Dist. AVAIL. and/or SPECIAL
A

FTD ID(RS)I-0391-77

EDITED TRANSLATION

FTD-ID(RS)I-0391-77 30 March 1977

FTD-77-C-000315

CSI73016977

EFFICIENCY OF MULTISTAGE COMMUNICATION SIGNAL SEARCH WITH CONSIDERATION OF RECEIVER COMPLEXITY

By: Yu. S. Agafonov

English pages: 7

Source: Izvestiya Vysshikh Uchebnykh Zavedeniy Radioelektronika, Vol 15, NR 11, November 1972, PP. 1386-1388.

Country of origin: USSR
Translated by: Carol S. Nack
Requester: DRDMI/YDL
Approved for public release; distribution unlimited.

THIS TRANSLATION IS A RENDITION OF THE ORIGINAL FOREIGN TEXT WITHOUT ANY ANALYTICAL OR EDITORIAL COMMENT. STATEMENTS OR THEORIES ADVOCATED OR IMPLIED ARE THOSE OF THE SOURCE AND DO NOT NECESSARILY REFLECT THE POSITION OR OPINION OF THE FOREIGN TECHNOLOGY DIVISION.	PREPARED BY: TRANSLATION DIVISION FOREIGN TECHNOLOGY DIVISION WP-AFB, OHIO.

U. S. BOARD ON GEOGRAPHIC NAMES TRANSLITERATION SYSTEM

Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*<u>ye</u> initially, after vowels, and after ъ, ь; <u>e</u> elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

GREEK ALPHABET

Alpha	Α	α	α		Nu	Ν	ν	
Beta	Β	β			Xi	Ξ	ξ	
Gamma	Γ	γ			Omicron	Ο	ο	
Delta	Δ	δ			Pi	Π	π	
Epsilon	Ε	ε	ϵ		Rho	Ρ	ρ	ϱ
Zeta	Ζ	ζ			Sigma	Σ	σ	ς
Eta	Η	η			Tau	Τ	τ	
Theta	Θ	θ	ϑ		Upsilon	Τ	υ	
Iota	Ι	ι			Phi	Φ	φ	ϕ
Kappa	Κ	ϰ	κ	ϰ	Chi	Χ	χ	
Lambda	Λ	λ			Psi	Ψ	ψ	
Mu	Μ	μ			Omega	Ω	ω	

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}

---

rot	curl
lg	log

GRAPHICS DISCLAIMER

All figures, graphics, tables, equations, etc. merged into this translation were extracted from the best quality copy available.

EFFICIENCY OF MULTISTAGE COMMUNICATION SIGNAL SEARCH WITH CONSIDERATION OF RECEIVER COMPLEXITY

Yu. S. Agafonov

The elimination of initial frequency and time ambiguity in communication systems with pseudorandom discrete phase-manipulated signals requires large amounts of time. The signal search time can be reduced by using multistage procedures and multichannelling. Then the number of stages and channels providing the minimum mean signal search time at a fixed complexity and given quality of detection are determined. The plane of ambiguity is broken down into rectangular cells. The sides of the rectangle are equal to the frequency and time search intervals. The search intervals are selected to obtain the minimum search time, with the reduction in the level of the signal

ambiguity function being 0.5 in this case [1]. Signal search consists of determining the position of a cell on the parameter plane.

We will use the multistage procedure with single-threshold sampling of cells characterized by the gradual improvement of detection quality from stage to stage [2, 3].

After sequential testing of cells in the first stage, the number of cells selected in each successive stage is random and we will assume that its distribution adheres to the binomial law [2, 3].

The quality of detection for the independent solutions found in the stages of an L-stage procedure is characterized by the probabilities of correct detection and false alarms [1-3]:

$$D = \prod_{i=1}^{L} D_i, \qquad (1)$$

$$F = \prod_{i=1}^{L} F_i, \qquad (2)$$

where D_i, F_i are the probabilities of correct detection and false alarm, respectively, in the i-th step.

The total mean search time in the absence of a signal [1]

$$T = \frac{fN}{0,6}\left(T_1^2 + F_1T_2^2 + \dots + \prod_{i=1}^{L-1} F_iT_L^2\right), \qquad (3)$$

where f is frequency ambiguity, Hz; N is time ambiguity, expressed in the number of elementary pulses of the pseudorandom signal; and T_i is the signal accumulation time in a cell in the i-th stage.

The total minimum of nonlinear function (3) with boundary conditions (1) and (2) is found by dynamic programming [3, 4]. The procedure is optimized on a Minsk-22 computer for the detection of a signal whose amplitude fluctuates according to Rayleigh's law in normal stationary noise and whose phase is evenly distributed in the interval [0-2π], when [5]

$$F_i = m_i D_i^{1+\rho T_i}, \qquad (4)$$

where m_i is the number of channels in the i-th stage; ρ is the signal/noise ratio in the signal band.

We will point out that signal search is terminated at the time of arrival in the first stage. The number of channels in the first stage of search is

$$m_1 = m_t + m_f. \quad (5)$$

where m_t and m_f are the number of time of arrival and frequency channels, respectively.

The number of channels in each successive stage is equal to m_f.

We found the value of the gain in search time Q for the multistage procedure with several channels compared to the single-stage procedure with one channel at a detection quality of D = 0.9, F = 10^{-10}. The curves in Fig. 1 show the gain in search time for the two- (---), three- (——) and four- (-.-.-.-.) step procedures, depending on m_1 with parameter m_f (the numbers on the curve).

The solutions used for selecting the best version of the search system should be based on the selection of the so-called "preferable" versions, i.e., those for which all the remaining solutions result in excessive expenditures or an insufficient reduction in search time. A number of versions of constructing the search system were compared by this method. We will use the following complexity model:

$$c = 1 + k_t m_t + k_f m_f + k_{\text{эт}} L m_f. \quad (6)$$

where k_t, k_f are coefficients which consider the complication of

the receiver from the addition of each time and frequency search channel, respectively; $k_{\text{эт}}$ is a coefficient which considers the complication of the receiver due to the introduction of more than one stage.

As an example of the calculation of the efficiency of a search system which provides a 100-fold search time gain, the coefficients in formula (6) can be rather arbitrarily selected as follows:

$$k_t = 0{,}25; \quad k_f = 0{,}25; \quad k_{\text{эт}} = 0{,}15.$$

The curves in Fig. 1 show that a given gain in search time can be obtained with a different number of channels in each procedure. The dependence of the search time gain (for the two- (---), three- (——) and four- (-.-.-.) step) procedure on complexity is plotted in Fig. 2 for each version of the solution to the problem. The numbers on the curves show the number of frequency and time of arrival channels, respectively. For this example ($D = 0.9$, $F = 10^{-10}$) the structure of the search system should be: the three-step search procedure should be used; four channels each should be used for time and frequency search.

We can use the curves (Fig. 1) to find the optimum structure of the search system in each case for other complexity models.

Received 7 June 1971

After revision 23 September 1971

Bibliography

1. Агафонов Ю. С., Свириденко С. С., К оптимизации двухэтапного поиска сигнала в системе связи, Радиотехника и электроника, 1971, 16, № 1.
2. Кобзарев Ю. Б., Башаринов Д. Е., Об эффективности алгоритмов поиска, основанных на методе пробных шагов управляемой длительности, Радиотехника и электроника, 1961, 6, № 9.
3. Акиндинов В. В., Относительная эффективность оптимального алгоритма многоэтапного поиска, Изв. АН СССР, Техническая кибернетика, 1966, № 4.
4. Беллман Р., Динамическое программирование, Изд-во ин. лит-ры, 1960.
5. Вайнштейн Л. А., Зубаков В. Д., Выделение сигналов на фоне случайных помех, Изд-во «Советское радио», 1960.

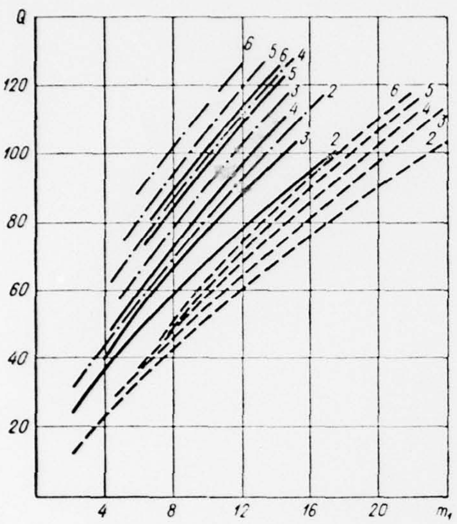
Q
120
100
80
60
40
20
4
8
12
16
20
m
6
5
6
4
5
3
2
4
3
2
6
5
4
3
2

Fig. 1.

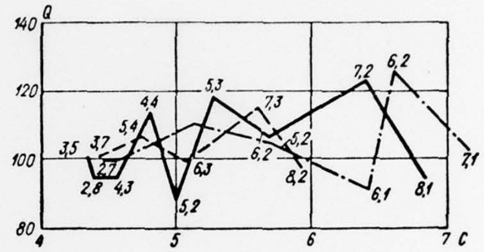
140
Q
120
100
80
4
5
6
7
C
3,5
3,7
5,4
4,4
2,8
2,7
4,3
5,2
6,3
5,3
7,3
6,2
5,2
8,2
7,2
6,2
6,1
8,1
7,1

Fig. 2.

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER FTD-ID(RS)I-0391-77	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EFFICIENCY OF MULTISTAGE COMMUNICATION SIGNAL SEARCH WITH CONSIDERATION OF RECEIVER COMPLEXITY		5. TYPE OF REPORT & PERIOD COVERED Translation 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Yu. S. Agafonov		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Foreign Technology Division Air Force Systems Command U.S. Air Force		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE November 1972 13. NUMBER OF PAGES 7
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED 15a. DECLASSIFICATION DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) 17		

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DISTRIBUTION LIST

DISTRIBUTION DIRECT TO RECIPIENT

ORGANIZATION	MICROFICHE
A205 DMATC	1
A210 DMAAC	2
B344 DIA/RDS-3C	8
C043 USAMIIA	1
C509 BALLISTIC RES LABS	1
C510 AIR MOBILITY R&D LAB/FIO	1
C513 PICATINNY ARSENAL	1
C535 AVIATION SYS COMD	1
C557 USAIIC	1
C591 FSTC	5
C619 MIA REDSTONE	1
D008 NISC	1
H300 USAICE (USAREUR)	1
P005 ERDA	2
P055 CIA/CRS/ADD/SD	1
NAVORDSTA (50L)	1
NAVWPNSCEN (Code 121)	1
NASA/KSI	1
544 IES/RDPO	1
AFIT/LD	1

ORGANIZATION	MICROFICHE
E053 AF/INAKA	1
E017 AF/RDXTR-W	1
E404 AEDC	1
E408 AFWL	1
E410 ADTC	1
E413 ESD	2
FTD	
CCN	1
ETID	3
NIA/PHS	1
NICD	5